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'Good Engineering Governance' - an issue for Ergonomists

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'Good Engineering Governance' - an issue for Ergonomists

Abstract

Engineering Governance can be summarised as two questions: 'Are we doing the right things?' and 'Are we doing those things right?'. It forms a part of Corporate Governance, and in the manufacturing domain it is the key to long-term survival amid changing commercial contexts. The paper will outline some of the ergonomics issues of importance in this topic; 'ownership' of goverrnance; implications for design, production and operation; and, perhaps most important for Ergonomists, the resulting implications for the design of jobs. These implications cover organisational discipline, the inclusion of suitable, 'effort-free' metrics in engineering processes, the allocation of responsibility and authority over resources, support for individuals, the need for trust and a culture of honesty and reliability, and the necessity for organisational follow-through.

Keywords

governance', ergonomists, engineering, issue, 'good, -

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'Good Engineering Governance' - an issue for Ergonomists

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Abstract

Engineering Governance can be summarised as two questions: 'Are we doing the right things?' and 'Are we doing those things right?'. It forms a part of Corporate Governance, and in the manufacturing domain it is the key to long-term survival amid changing commercial contexts.

The paper will outline some of the ergonomics issues of importance in this topic; 'ownership' of goverrnance; implications for design, production and operation; and, perhaps most important for Ergonomists, the resulting implications for the design of jobs. These implications cover organisational discipline, the inclusion of suitable, 'effort-free' metrics in engineering processes, the allocation of responsibility and authority over resources, support for individuals, the need for trust and a culture of honesty and reliability, and the necessity for organisational follow-through.

Keywords: ODAM, systems_ergonomics, control, governance, process_design, knowledge_management

1. Introduction

Engineering governance is focussed on the control that is present through the hierarchy of the organisation with respect to the engineering function. This control is an important lever for the executive management that is responsible for corporate governance to enable them to to assure customers, stakeholders, shareholders and the legal system that projects will meet the requirements (both those of the customers and of the business). In essence, engineering governance addresses the twin questions, “Are we doing the right things?” and “Are we doing those things right?”. If the answers to these two questions are affirmative, then the organization is heading towards a ‘no nasty surprises’ state of operations.

However, this rather simplistic viewpoint ignores the contribution of complexity to the problems of control. In this paper we discuss some of the ways in which complexity can manifest itself behaviourally, and then discuss ways and means by which these effects can be sequestered, ameliorated, and, in certain situations, quenched. These ways and means can be seen to be a part of engineering governance, albeit at a somewhat deeper level than implied in the questions above.

2. How does complexity manifest itself?

There is a considerable literature on complexity; one good text for explaining it is Rycroft & Kash

(1999). In more common parlance, complexity shows itself in the form of Murphy's Law – 'if it can go wrong, it will go wrong'; this is often extended with the corollary, '… and it will go wrong at the worst possible time'.

The main findings are that complexity usually manifests its presence by emergent, almost always undesirable, behaviour, not envisaged by the system designers nor expected by the systems operators. Secondly, it has diffuse origin; decomposition of the system to discover its causes may show that individually the system components are reliable, but not when grouped. Thirdly, complex problems require at least equal complexity in the knowledge and approaches to solve them (a version of Ashby's Law, 1956), though the solution might be simple. Finally, it is said that for innovation to happen within the organisation, at least some parts must operate 'at the edge of chaos'. The implication is that complexity will always be a factor in the organisation's behaviour; channelling its effects is a challenge for management.

Complexity can be decomposed into two overlapping classes; firstly, intrinsic complexity which arises because the problem we are facing is by its nature a complex one (e.g. wide area traffic management), and secondly, induced complexity because we have organised ourselves inappropriately to address it (e.g. project teams appointed on availability grounds, not on expertise). Our concern, from a governance aspect, is mainly with the latter, though because of the overlap we discuss both. Fig 1 shows this, for the design process.

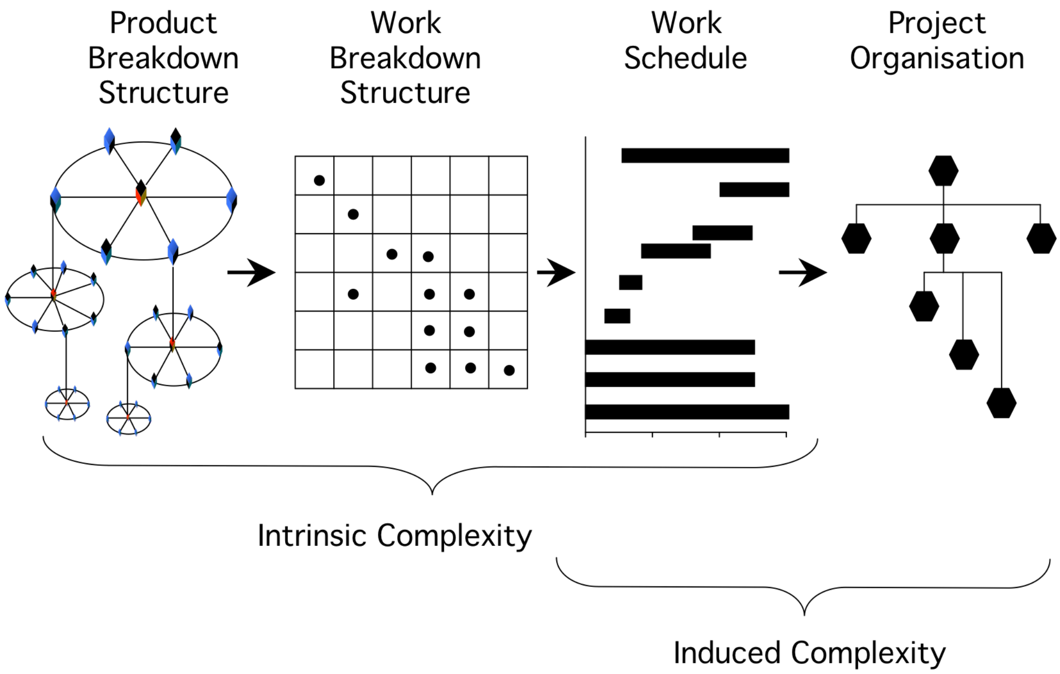

Figure 1 Diagram outlining the organising and resourcing of a design project. This depicts simply the relationships between intrinsic and induced complexity

The symptoms of complexity within a design project include:

- The slow, gradually-spreading realization that the project is much more difficult than originally thought, due to unexpected interactions and feedbacks;
- project management characterized by near-continuous fire-fighting, due at least in part to a commitment to inflexible work schedules;
- considerable rework of supposedly completed components, due in part to out-of-phase development of components in a concurrent engineering environment;
- self-evidently dysfunctional teams, because of organizational problems not recognized early enough;
- failures of organisational learning, because nobody has the time to attend to this, since they

are dealing with all the issues above;
- failures in the delivery of service, leading to contract penalties.

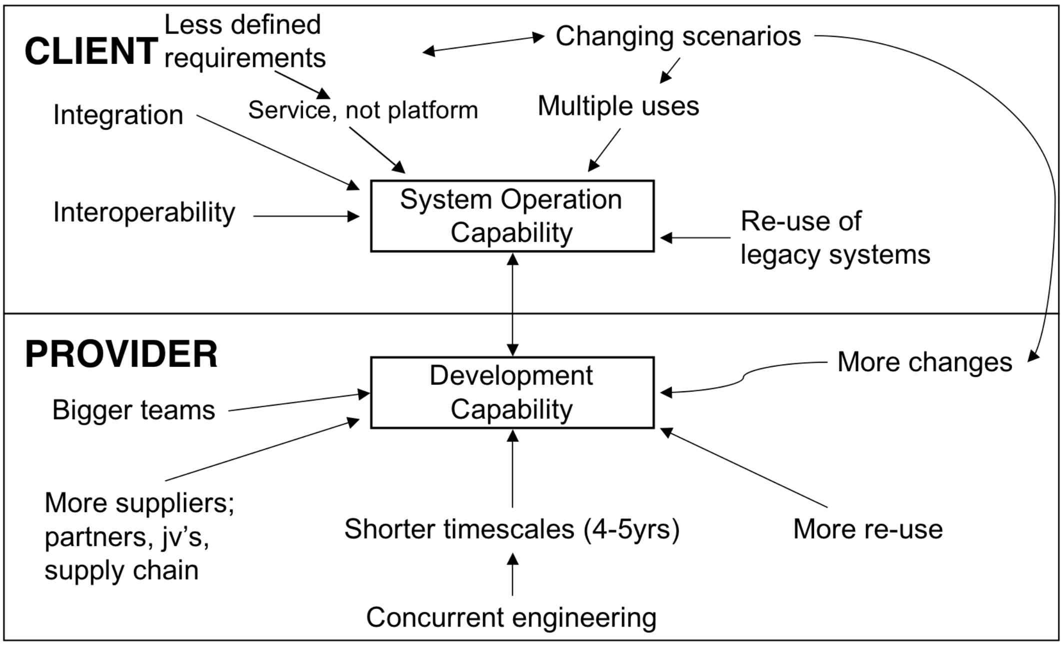

Figure 2: Client-provider relationships, as they are changing over this decade. On the client side, the drivers that are altering the nature of the need are shown. The result is that the client specifies a desired capability to be delivered, not a product or system. The provider has now to decide this, and the implications are shown. In effect, much of the complexity the client had to manage before is exported to the provider.

The increase of complexity on the provider's side has now to be accommodated, and its associated emergent behaviour, additional to that present before, needs to be contained. The sources of complexity in this diagram, additional to those listed before, include:

- Many agents, of different kinds
- An evolving, uncertain, environment (client, suppliers, weather, etc.)
- Lots of connections between agents, who are
- Communicating in parallel
- Some degree of behavioural autonomy for agents, with
- Multiple steady states for agents, and
- Evolution of the agents
- Interactions between agents across system boundary
- Interactions between different goals within an agent
- Interactions between agents with different goals
- Language/culture differences
- Restricted time (deadlines, interruptions, etc.)

If only a few of these characteristics are present, it is likely that emergent behaviour will arise, and that it will not be to the advantage of the project.

3 . Containing the effects of complexity

Note that we talk about 'containing' complexity, not its elimination. Hence, there is a need for continuous attention to the control measures, emphasising the need for engineering governance. We discuss firstly intrinsic complexity, and then induced complexity.

Organising for intrinsic complexity involves the following:

- Modularity in design, to enable containment of complexity

- Maturity of system components is vital - i.e. the state of knowledge, and quality of knowledge management is critical. These are long-term issues
- Points to the need for an architecture for core components of the system, and rigid adherence to standards
- Requires a good prior understanding of the problem context; especially of interactions and non-linearities
- Requires stability of project environment - budget, timescales, client consistency and coherence, partners, etc. (this is best addressed within induced complexity).

It will be noted that all of these are concerns for engineering governance; unless there are polices, procedures and practices for these, and they are maintained, intrinsic complexity can spiral out of control. In addition to these are the demands for induced complexity:

- Need to consider containment measures at project strategy level, workgroup level, and individual level.
- Make use of the important role of humans as 'Complexity Absorbers' – the situation may be complex, but a simple plan may suffice. This capability depends on:
  - Trust in other system components (especially the human ones)
  - Situation awareness, and shared situation awareness
  - Excellent communications
  - Knowledge & experience
- These all depend on job design, the organisation of work, reponsibilities and authority over resources, culture, values, and many other organizational aspects.

These all fall within the ambit of engineering governance; the inclusion of social considerations such as culture and policies, becomes evident. To draw an analogy, if people start from the same place, and want to march in the same direction, and they all march in the same fashion, it becomes much easier to control the march.

4 An Engineering Governance framework

We report on nearly-completed work within an aerospace company. Several case studies have been executed in differenrt business units, and corroborative work has commenced into other classes of organisation in other domains, to generality of the findings.

For a commercial business, governance must address four aspects;

- Meeting legal requirements for health & safety, probity, and so on
- Ensuring the development, at acceptable risk, of competitive offerings for its customers
- Ensuring the offerings are to specification
- Delivering the offering to the customer to the business benefit of the enterprise.

From these, a given project will establish its own business objectives. For each of these, it will be necessary to develop a governance process, covering the business objective stakeholders, with appropriate metrics and with a process owner responsible for good governance for that objective. Typically, in the company concerned, this individual turns out to be a Chief Engineer. Chief Engineers usually have responsibilities for all four of the aspects above, so most of the governance processes will be owned by such an individual within the project, and streamlined processes can therefore be adopted.

Some governance mechanisms will already be in existence; design reviews, for example. Others may need to be extended, or developed; appraisals of individuals and their contributions, for example. Still others may be ignored; it is unlikely that the governance of all processes will be cost-effective or even feasible.

There are several key issues that must be borne in mind in developing governance:

- Essentially, governance involves humans. Therefore, the processes and the metrics must be human-sensitive (i.e. as unobtrusive as possible), and of evident benefit, else false data or no data will accrue.
- Governance should measure only that which is necessary to achieve the business objective. It is a mistake to try to measure everything. With a little subtlety, it should be possible to adopt metrics which will indicate emergent behaviour and its likely source to enable containment of the complexity that might occur [4, 5]. At the last count,
- There must be clear responsibilities to act on the basis of the measures, and procedures and resources available for actions to take place. This should include disciplinary processes [6]as well, for the more egregious departures from desired behaviour.

Finally, a UML class diagram, together with a process for using it, are nearly finalised to enable managers and others to develop appropriate governance structures for their projects.

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